Center Independent Research & Development: JPL IRAD

Qualified Electronics for Extreme Cold Environment (QEECE)

Completed Technology Project (2016 - 2019)

Project Introduction

Many high value targets in the solar system require exposing the spacecraft to extremely low temperature environments. Of special interest to NASA are missions to Ocean Worlds (Titan, Enceladus, Ganymede, Europa…) as well as permanently shadowed regions of the Moon, comets, and high latitude winters on Mars. Meeting the scientific goals of these missions relies on revolutionizing current spacecraft and instrument technologies to achieve long life, high resolution and sensitivity but with low mass and power requirements. Our goal is to formulate and demonstrate an extreme environment electronics characterization and modeling methodology to demonstrate the feasibility of utilizing selected commercial electronic components for in-situ operation during NASA's missions to extremely cold environments.

Our objective is to formulate and develop extreme environment electronic characterization and modeling methodologies that quantify the extended operating range of commercial components. This will enable the development of qualified high reliability electronic components capable of in-situ operation during NASA's missions to extremely cold environments. We have used a spacecraft subsystem as a pathfinder catalyst for validation and proof of concept demonstration of our objectives. The extended operating range of the candidate components identified through the smart search will be validated through empirical evaluation that includes temperature dependent electronic reliability experiments, low temperature radiation evaluation, life test and failure analysis studies . Based on our characterization, our collaboration partners at the University of Tennessee have begun to look at "macro-based" modeling and simulation techniques for estimating the extended performance of the candidate parts in extreme environment.

Anticipated Benefits

When complete, the methodology will demonstrate the feasibility of utilizing selected commercial electronic components for in-situ operation during NASA's missions to extremely cold environments thus potentially expanding the cold operation capability of current missions such as Europa Clipper or Mars 2020 as well as potential Mars sample return missions. This methodology will also be suitable for in-situ operation during any government missions and commercial space activities, such as satellites which may need electronics to function in extremely cold environments. Cold electronics applications of this methodology, such as quantum computing or cryogenic systems, will also support the technology development of our nation.

JPL_IRAD_Activities Project

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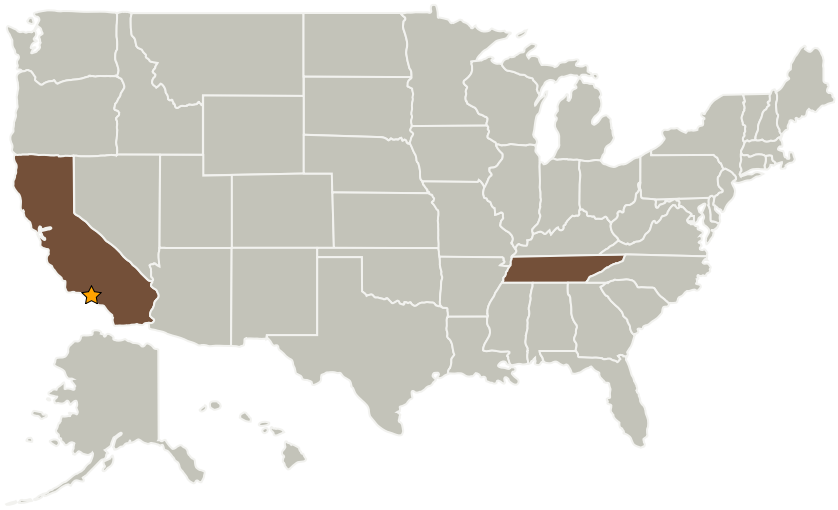
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
The University of Tennessee-Knoxville(UT-K)	Supporting Organization	Academia	Knoxville, Tennessee

Primary U.S. Work Locations	
California	Tennessee

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Jean Yang-scharlotta

Co-Investigators:

Mohammad Ashtijou
Linda Y Del Castillo
Benjamin Blalock
Miryeong Song

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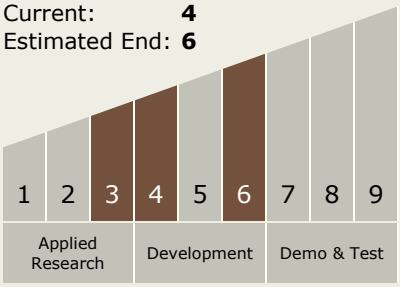
Images

JPL_IRAD_Activities Project Image
JPL_IRAD_Activities Project
(https://techport.nasa.gov/image/28332)

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **6**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.2 Launch Vehicle Propellant

Target Destinations

Foundational Knowledge, Others Inside the Solar System

Supported Mission Type

Push